EXECUTIVE SUMMARY
FINAL REPORT
Of

ENERGY ENGINEERING ANALYSIS (EEA) PROGRAM

For

LOUISIANA ARMY AMMUNITION PLANT
LOUISIANA

Prepared for

UNITED STATES ARMY DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

Under

CONTRACT NO. DACA 63-79-C-0177

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MAY 1982

EXECUTIVE SUMMARY

ENERGY ENGINEERING ANALYSIS (EEA) PROGRAM
LOUISIANA ARMY AMMUNITION PLANT

INTRODUCTION

The objective of this Energy Engineering Analysis (EEA) for Louisiana Army Ammunition Plant (LAAP) is to develop a systematic plan of projects which will result in the reduction of energy consumption at LAAP in compliance with the objectives set forth in the Army Facilities Energy Plan dated 1 October 78. The long range objective of the Army is to implement a policy under which LAAP will become as energy efficient as the state of the art for energy conservation will allow. In development of the planned projects, an assessment of the entire energy picture at LAAP was completed. This report is a summary of that effort.

LAAP is a government-owned, contractor-operated (GOCO) military industrial installation under the jurisdiction of the Commander, U.S. Army Armament Material Readiness Command. The facility was built during 1941 and 1942 to serve as an ammunition loading plant. At the end of World War II, LAAP was placed on standby status, and the government assumed responsibility for its operation. Sperry Rand Corporation was selected in 1951 to reactivate and operate the plant during the Korean Emergency. Major rehabilitation efforts followed, including the design and construction of a forging and machine plant. The plant was again placed on standby status in 1958. The Southeast Asia conflict brought about reactivation in 1961. Thiokol-Louisiana Division was awarded the operating contract in 1975, replacing Sperry Rand Corporation, which had operated the plant since 1951. LAAP encompasses an area of about 14,974 acres located approximately 18 miles east of Shreveport, Louisiana.

MISSION

The mission areas of LAAP are as follows:

- Loading, assembly, and packing of ammunition items.
- Manufacturing metal parts for ammunition.
- Receipt, surveillance, maintenance, renovation, demilitarization, storage, and issue of assigned field service stocks.
- Procurement, receipt, storage and issue of essential materials.
- Industrial preparedness planning.

In carrying out its mission, Thiokol-Louisiana Division presently employs about 800 people to perform the various functions of LAAP.

DATA BASE FOR ANALYSIS

The study commenced with the collection of all the raw data and information required to determine the distribution and forms of present energy consumption.

The raw data and information consist of building envelope characteristics, type and method of operating environmental and process energy systems, building population and occupancy schedules, and historical energy usage. These data were then used to develop a detailed energy data base for the entire facility. The energy data base delineates the form and quantity of energy consumption from the receiving point, through conversion processes, and on to the point of end use for heating, cooling, lighting, and process. The detailed picture of present energy consumption is then used to identify energy conservation opportunities (ECOs) and to serve as a gauge against which energy savings calculations can be compared.

For LAAP, present energy consumption was considered to be the actual total energy consumption recorded for FY1980, which was the most recent complete year of data when the study commenced. Thus, the energy data base used is a detailed breakdown of the actual total energy consumption for FY1980. Table ES-1 below shows the composite breakdown for an energy consumption assessment in six categories. A more detailed breakdown on a building-by-building basis may be found in Table 3.9 beginning on page 3-23 in Volume I of the report.

TABLE ES-1

ENERGY DATA BASE (FY1980)

	FOSSIL FUEL		ELECTRICITY		TOTAL SOURCE	
	mBtu	% of TOTAL	kWh	% of TOTAL	mBtu	% of TOTAL
Heating	65,571	28.4	608,000	4.7	72,624	19.1
Cooling	-	-	1,272,000	9.9	14,755	3.9
Lighting	-	-	1,451,000	11.3	16,832	4.4
Process	88,766	38.5	6,604,000	51.5	165,372	43.6
Other:						
o Distribution and transformer losses	9,811	4.3	1,124,000	8.8	22,849	6.0
o Conversion losses	37,283	16.2	-	-	37,283	9.8
o Condensate losses	15,619	6.8	-	-	15,619	4.2
o Domestic hot water and miscellaneous	2,774	1.2	146,000	1.1	4,468	1.2
o Little use facilities	10,703	4.6	1,591,000	12.3	29,159	7.7
o Exterior lighting	-	-	47,000	0.4	545	0.1
Totals	230,527	100.0	12,843,000	100.0	379,505	100.0

*Electrical energy converted to source energy by using 11,600 Btuh/kWh.

EVALUATION OF ENERGY CONSERVATION OPPORTUNITIES

Potential ECOs were found to exist in a number of areas during the initial energy analysis. Typical building envelope ECOs were identified, along with opportunities in process ventilation systems, outside air reductions, steam and condensate return system modifications, boiler blowdown heat recovery, and lighting systems. The implementation of an Energy Monitoring and Control System (EMCS) was also determined to offer energy savings. All ECOs were evaluated to determine feasibility in accordance with the requirements of the Energy Conservation Investment Program (ECIP) guidelines.

Since many ECOs are interrelated (i.e., the savings of one affect the savings of another), the energy conservation analysis of a building with multiple ECOs was performed in the following sequence to account for those interrelationships:

- The building envelope was evaluated first to ensure that it was as weathertight as is economically feasible under ECIP guidelines.

- Centralized control of energy systems through use of an Energy Monitoring and Control System (EMCS) was evaluated next.

- Next, the heating, ventilating, air conditioning, and exhaust systems were evaluated, assuming the feasible building envelope ECOs were implemented. Internal process systems and functions were evaluated at the same time, provided they did not affect the functional requirements being performed.

- Internal and external building steam distribution, compressed air, chilled water and lighting systems were evaluated.

The results of the detailed analysis of ECOs, including the EMCS, based on ECIP criteria are summarized in Table ES-2 on page ES-4. ECO descriptions and identification of buildings to which they apply may be found in Volume I, Sections 4.0 and 5.0 of this report.

TABLE ES-2

LAAP

FEASIBLE ENERGY CONSERVATION OPPORTUNITIES

(INCREMENTS A AND B)

ECO Description	Annual Energy Savings Fossil Fuel (10^6 Btu/yr)	Annual Energy Savings Electricity (kWh/yr)	Capital Cost* Estimate (FY 1984$)	E/C Ratio
BUILDING ENVELOPE:				
Sealant and Weather-stripping	6,279	5,631	$101,820	62.8
Roof Insulation	6,582	8,841	$330,330	20.2
Wall Insulation	6,422	91,341	$167,590	44.6
Window Insulation and Screens	0	27,400	$ 11,815	26.9
HVAC ECOs:				
Auto Ignition and Vent Dampers	1,896	0	$125,650	15.1
Outside Air or Supply Air Reduction	84	0	$ 2,860	29.3
Ceiling Fans	237	(4,380)**	$ 8,700	21.4
PROCESS SYSTEM OPPORTUNITIES:				
Heater Hut Insulation	0	94,000	$ 10,800	100.9
Reduce Volume of Heating Bays	555	24,500	$ 52,710	15.9
Isolation of Inactive Areas	540	0	$ 21,130	25.6
BUILDING, LIGHTING SYSTEMS MODIFICATIONS:				
Fluorescent Fixture Replacement	0	76,030	$ 47,700	18.5
Replace Exterior 400 W MV Lighting	0	20,510	$ 14,880	16.0
Delamping	0	94,000	$ 5,420	201.2
UTILITIES AND ENERGY DISTRIBUTION SYSTEMS MODIFICATIONS:				
Boiler Heat Recovery	1,180	0	$ 19,260	61.3
Boiler Combustion Control System Modification	2,700	0	$ 89,470	30.2
OTHER CONSIDERATIONS:				
Showerhead Flow Restrictors	252	0	$ 5,990	42.1
DHW Heater Insulation Jackets	90	10,417	$ 3,470	60.8
DHW Vent Damper	130	0	$ 3,720	34.9
EMCS	11,362	236,908	$751,131	18.8
TOTAL	38,309	685,198	$1,774,446	26.1

*Per ECIP escalation Criteria

**( ) indicates an increase in energy consumption.

These feasible ECIP ECOs represent an energy savings of 16.6% in fossil fuel consumption and 5.3% in electrical energy use, when compared to the FY1980 data base. This equates to a reduction in total source energy of 12.2%. Based on FY1975 levels of energy consumption, these ECIP ECOs will accrue annual energy consumption reductions of 7.8% for fossil fuel, 4.4% for electricity, and 6.9% for total source energy. Together with other reductions already accomplished at LAAP, the total source energy reductions since FY1975 by FY1985 at LAAP will be 50.4% when these feasible ECIP ECOs have been implemented.

The feasible ECIP ECOs, based on a E/C ratio of 13 or greater*, were developed into FY 1984 ECIP projects for funding. Form 1391s and Project Development Brochures (PDBs) were prepared and are submitted with this report. Identification of these projects and the ECOs contained within them is as follows:

TABLE ES-3
ECIP PROJECTS-LAAP

Project No.	Project Title	ECOs Included in Project
LAAP - I	Roof Insulation for Plant Buildings	Roof Insulation
LAAP - II	Weatherization of Plant Buildings	Sealant and Weatherstripping Wall Insulation Window Insulation and Screens
LAAP - III	Process and Boiler Modifications	Heater Hut Insulation Isolation of Inactive Areas Reduce Volume of Heating Bays Boiler Heat Recovery Boiler Combustion Control System Modifications
LAAP - IV	HVAC, Lighting and DHW System Modifications	Auto Ignition and Vent Dampers Outside Air or Supply Air Reduction Ceiling Fans Delamping Replace Exterior 400W MV Lighting Fluorescent Fixture Replacement DHW Vent Dampers DHW Heater Insulation Jackets Showerhead Flow Restrictors
LAAP - V	Energy Monitoring and Control System (EMCS)	Energy Monitoring and Control System

In preparing the programming documents, economic computations, and DD Form 1391s for each project, guidance was received from the Fort Worth District, Corps of Engineers as follows**:

- o Construction cost escalation factors, provided by AR-415-17 and EIRS Bulletin, should be used to calculate construction cost in Paragraph 1 of the ECIP Economic Analysis Summary, and Items 8 and 9 of DD Form 1391 (Project Cost and Cost Estimates).

- o Differential fuel escalation rates set forth in the ECIP guidance should be used to calculate energy costs in Paragraphs 2 and 3 of the ECIP Economic Analysis Summary.

These guidelines were used in preparing each project for FY1984 funding and in adjusting the economic justification to that year. Construction costs were escalated to Midpoint of Construction Date (MCD) per AR-415-17 and fuel costs were escalated per ECIP criteria.

* DAEN-MPO-U TWX dated 29 December 80.
** 27 February 81

Based on ECIP criteria and project costs for the programming year, a summary of the project results is presented in Table ES-4 below:

TABLE ES-4

ECIP PROJECTS - LAAP
(FY1984)

Project Number	Project Title	Energy Savings (mBtu/yr)	Project Cost (FY84$)	E/C Ratio	B/C Ratio	Payback Period (Yrs)
LAAP-II	Weatherization of Plant Buildings	14,117	$346,600	40.7	4.2	4.45
LAAP-III	Process and Boiler Modifications	6,350	242,400	26.2	2.72	6.8
LAAP-IV	HVAC, Lighting, and Domestic Hot Water Modifications	4,971	270,900	18.4	1.28	9.4
LAAP-I	Roof Insulation for Plant Buildings	6,684	385,600	17.3	1.79	11.3
	TOTAL	32,122	$1,245,500	25.8		
LAAP-V	Energy Monitoring and Control System (EMCS)*	14,110	752,500	18.8	1.00	14.1

* The EMCS project is listed separately, because it is understood that a separate source of ECIP funding is specifically set aside for EMCS projects.

The projects evaluated in Increments A and B and listed in Table ES-4 above represent logical groupings of ECOs which are associated based on application or implementation means. Except for the EMCS, the projects are listed in the order of the recommended sequence of implementation.

BIOMASS FEASIBILITY STUDIES

The current level of forestry management practiced at LAAP devotes primary attention to one of six "compartments" each year on a rotational basis. Using FY 1980 as a representative year, the annual sustaining yield would be 19,337 tons per year (approximately 0.8 dry tons per acre) as shown below in Table ES-5; of this yield, 10,758 tons would be considered available as a biomass fuel source.

TABLE ES-5
LAAP ANNUAL SOURCES OF BIOMASS

BIOMASS SOURCE	ESTIMATED QUANTITY AVAILABLE(tons/yr)	MOISTURE CONTENT (WET BASIS)	HEATING VALUE (Btu/lb)	ENERGY AVAILABLE (mBtu/yr) INPUT
Commercial Harvested Timber	8,579*	50%	4,300	73,779
In-Forest Harvest Residue	1,223**	50%	4,300	10,518
Unmerchantable Timber Stands	9,535***	50%	4,300	82,001
Timber Waste Created By Maintenance or Construction Projects	0	-	-	0
Total Biomass	19,337	50%	4,300	166,298
Biomass Available For Fuel	10,758	50%	4,300	92,519

*From 1980 harvest data listed on natural resources report.

**Estimated quantity of residue based upon methods developed by R. L. Welch.

***Unmerchantable timber quanity based upon 8 year regenerative cycle.

(Source: Welch, R. L., "Producing Logging Residues for the Southeast", U.S. Department of Agriculture).

A life cycle cost analysis was performed on two alternative concepts at LAAP. First, it was noted that there is insufficient biomass fuel (92,519 mBtu per year) to support all major production areas. Areas S, B, C and D offer potential in that the plant size and loads can be possible conversions to biomass, in some form. For example, Area S alone has an annual input fuel requirement of 137,490 mBtu, which is greater than the biomass fuel available. Two concepts were developed:

Concept 1 - Convert Area B boilers to 100% biomass fuel. This concept requires all of the biomass fuel available.

Concept 2 - Convert Area B, C, D and S boilers to solid fuel, using a mixture of coal and wood as the fuel - 80% coal/20% biomass. This concept would also utilize nearly all of the biomass fuel available on an annual basis.

Both concepts would use conventional traveling grate spreader stoker boilers. New boiler houses, and fuel and ash handling systems would be required. Other possible conversion systems were assessed, such as low Btu gasification and fluidized bed boilers; however, capital cost and fuel cost savings of each are not as attractive as with the conventional traveling grate boilers. The economic comparison was based on natural gas, which is the fuel presently used. The comparative life cycle cost of both concepts compared to the existing condition (base case) is shown on Table ES-6 on the following page.

TABLE ES-6
LAAP-BIOMASS
LIFE CYCLE COST COMPARISON

	BASE CASE	CONCEPT 1 (B AREA CONVERSION)	CONCEPT 2 (B,C,D,S, AREA CONVERSION)
Capital Cost Estimate:*	$422,000	$1,728,000 320,000 2,048,000	$6,927,200
Annual Energy Consumption:			
Natural Gas (kcf)	358,309	280,737	0
Electricity***	0	112,200	560,800
Coal (tons)	-	-	16,163
Wood (tons)	-	11,275	9,171
First Year Annual Operating Costs*			
O&M	451,800	664,800	1,324,300
Energy			
Natural Gas	1,071,300	839,400	-
Electricity	-	3,700	18,500
Coal	-	-	727,300
Wood	-	150,860	122,700
Subtotal	1,523,100	1,658,800	2,192,800
Life Cycle Operating Costs**			
O&M	3,554,300	5,230,600	10,418,300
Energy			
Natural Gas	26,081,900	20,436,000	-
Electricity	-	77,400	387,000
Coal	-	-	11,335,000
Wood	-	2,351,200	1,912,300
Subtotal	29,636,200	29,754,000	24,052,600
Total Life Cycle Costs			
Capital Cost*	422,000	1,728,000	6,927,200
Operating Cost	29,636,200	29,754,000	24,052,600
TOTAL	$30,058,200	$31,802,000	$30,979,800

*Project cost estimate date (October 1981) dollars.
**Based upon a 25 year life cycle analysis commencing 1985 using appropriate DCG;
***Incremental electrical usage for in-plant auxiliary equipment.

As shown in Table ES-6, neither biomass conversion concept exhibits total life cycle cost savings compared with the base case, although both concepts involve significant life cycle fuel cost savings (12.3% and 47.7% respectively). However, the cost increase associated with operating and maintaining the more extensive solid fuel plant equipment, combined with the initial installation cost of such equipment, serves to offset these savings.

Although increased manpower and maintenance expenses are necessary to operate a solid fuel steam plant as compared with a gas fired steam plant, the extent of the increase varies. In a large central operation, many of the fuel handling functions can be consolidated or automated so the economic O&M penalty associated with solid fueled plants is minimized. Because of this, a central coal and wood fired heating plant may be more economically attractive than the base case.

Thus, based on the economic results of this study, it is not economically feasible to convert existing gas fired boiler plants at LAAP to wood fueled plants. However, Concept 2 has a life cycle cost that is only 3% greater than the natural gas base case. In view of the long range Army goal of eliminating natural gas use in boiler plants, this concept has merit and can be a scheduled conversion over a long period of time. However, it cannot be recommended based on economics.

It is recommended that no decision be made until the feasibility of a central coal and wood fired heating plant is evaluated and compared with the alternatives presented here.

INCREMENT G PROJECTS

Other ECOs were evaluated in the process of determining feasible ECIP projects. Those which were evaluated but did not meet ECIP criteria were considered further as possible Increment G projects. Additionally, several maintenance and repair ECOs were identified. Depending on the type of repairs which are necessary, some ECOs in this category were further grouped as those which would be performed as necessary; these were designated "unit basis operational and maintenance ECOs." "Unit basis" high efficiency replacement items were also evaluated.

The three groups of ECOs were evaluated for Increment G under ECIP criteria for common baseline comparison to Increment A and B projects. Using ECIP guidelines, energy savings, energy savings-to-cost (E/C) ratio, benefit-to-cost (B/C) ratios, man-hours to accomplish the work, and current working estimates (CWE) were developed. The economic summary of these evaluations for non-qualifying ECIP ECOs, maintenance and repair ECOs, and "unit basis" ECOs are presented in Tables ES-7, ES-8, ES-9 and ES-10 respectively on the following pages.

Because none of these projects had a capital cost more than $100,000 for a single project, and because of the nature of the implementation required for these projects, no 1391s and PDBs were prepared.

The maintenance and repair projects are shown and ranked by B/C ratio in Table ES-7. The "unit basis" ECOs are presented in Tables ES-8 and ES-9 on the following pages.

TABLE ES-7
MAINTENANCE AND REPAIR ECOs

DESCRIPTION	ANNUAL ENERGY SAVINGS (mBtu)	MAN-HOURS REQUIRED	CAPITAL COST (CWE) (FY84$)	E/C RATIO	B/C RATIO
Repair Steam Line Insulation	916	75.0	$5,370	170.0	14.4
Maintenance of Unit Heater Thermostats	273	5.5	386	707.0	4.8
Upgrade HVAC	140	19.5	687	203.8	3.5
Replace Unit Heaters in Building 103	138	12.0	2,980	46.3	2.0
Total	1,467	112.0	9,420	155.7	

TABLE ES-8
"UNIT BASIS" OPERATIONAL AND MAINTENANCE ECOs

DESCRIPTION	ANNUAL ENERGY SAVINGS PER UNIT (mBtu)	MAN-HOURS PER UNIT REQUIRED	UNIT COST (FY82$)	E/C RATIO	B/C RATIO
Flange, Valve, and Elbow Insulation					
12" Ø	96.5	1.5	$ 73.20	1,318.9	112.3
5" Ø	36.2	1.0	45.60	795.0	67.7
2" Ø	13.7	0.5	25.90	527.7	44.0
Repair or Replace PRVs					
Repair	32.6	0.5	30.00	1,086.6	22.1
Maintenance	32.6	0.5	7.80	4,152.8	17.4
Replacement	316.0	2.5	1,865.00	169.4	14.5
Repair Air Leaks	38.0	1.5	39.50	964.9	16.4
Steam Valve Maintenance					
Repair	22.4	1.0	36.70	610.4	12.4
Maintenance	22.4	0.5	15.70	1,426.7	6.0
Steam Trap Maintenance					
Repair	17.7	1.0	32.90	537.8	10.9
Replacement	17.7	2.0	146.40	120.9	10.3
Radiator Hand Valve Maintenance and Repair					
Repair	6.6	0.5	15.80	417.7	8.5
Replacement	6.6	1.0	156.00	42.3	3.6

TABLE ES-9
"UNIT BASIS" REPLACEMENT ITEM ECOs

DESCRIPTION	ANNUAL ENERGY SAVINGS PER UNIT (mBtu)	MANHOURS PER UNIT REQUIRED	INCREMENTAL UNIT COST (FY82$)	E/C RATIO	B/C RATIO
Replace Standard Fluorescent Lamps with High Efficiency Lamps					
Reduced Wattage	0.2	0	$ 0.60	413.8	9.3
White	0.2	0	0.80	300.0	6.7
Replace Unit Heaters with High Efficiency Heaters	66.0	0	415.00	159.0	7.4
Incandescent Conversion to Fluorescent Circline	1.5	0	20.70	70.8	5.1
Replace Standard Fluorescent Lamps and Ballasts with High Efficiency Lamps and Ballasts	0.3	0	4.30	82.0	4.1
Replace Standard Fluorescent Ballasts with High Efficiency Ballasts	0.2	0	2.80	69.8	3.3
Replace Window Air Conditioners with High Efficiency Window Air Conditioners	6.0	0	120.90	50.4	1.6

Electric Motor Replacement -

Motor HP	kW Saved	Price Premium FY82$	Operational Hours Per Year to Achieve B/C of 1
1	0.063	$60	2,589
2	0.041	54	3,581
3	0.123	69	1,525
5	0.117	82	1,905
7.5	0.195	85	1,185
10	0.143	120	1,903
15	0.447	136	820
20	0.441	154	949
25	0.470	171	989
30	0.475	189	1,082
40	0.821	255	844
50	0.810	301	1,010
60	0.826	440	1,448
75	0.845	558	1,795
100	1.301	661	1,381
125	1.351	835	1,680

ENERGY CONSERVATION PLAN - ENERGY SAVINGS SUMMARY

The Army Energy Plan has set a goal of 25% net energy consumption reduction by FY1985 based upon historic FY1975 energy consumption levels. A review of FY1980 energy consumption in comparison to FY1975 consumption shows a significant, 292,110 mBtu/yr or 43.5%, energy reduction has already been achieved by completed energy conservation projects and improved operation and maintenance procedures. Assuming implementation by FY85 of all the recommended ECIP projects including EMCS and the non-qualifying ECIP and maintenance and repair ECOs as evaluated under Increment G, Louisiana Army Ammunition Plant would achieve net annual energy savings since FY75 of 339,835 mBtu/yr, or a 50.6% reduction in comparison to FY75 energy consumption levels. An itemized summary of these projected energy savings is presented in Table ES-10 below.

TABLE ES-10

LAAP ENERGY PROFILE: FY75-FY85

Item	Annual Energy Use: Fossil Fuel (mBtu)	Annual Energy Use: Electric (kWh)	Annual Energy Savings: Fossil Fuel (mBtu)	Annual Energy Savings: Elec-tricity (kWh)	Annual Energy Savings: Source (mBtu)	% Savings
FY1975 Energy Use	489,912	15,664,000	-	-	-	-
FY1980 Energy Use	230,526	12,843,000	259,386	2,821,000	292,110	43.5
After ECIP Projects Implemented	192,213	12,157,802	38,309	685,198	46,257	6.9
After Increment G Implemented	190,745	12,157,802	1,468	-	1,468	0.2
Total			299,163	3,506,198	339,835	50.6

* Based on FY1975 energy use level.

RECOMMENDATIONS

As illustrated in Table ES-10 above, implementation of all Energy Conservation Opportunities recommended in Sections 4.0, 5.0, and 9.0 of this Report in addition to savings already realized will result in 50.6% net annual energy consumption reduction in comparison to FY1975 consumption levels, thus achieving Army energy conservation goals and DOD energy conservation goals for existing facilities as required by Executive Order 12003.

It is recommended that all five ECIP projects, all non-qualifying ECIP ECOs, and all Maintenance and Repair ECOs be implemented as soon as funding will permit.

A further reduction in energy can be achieved by the ongoing implementation of "unit basis" operational, maintenance, and replacement item ECOs. The establishment of such a program is highly recommended.